Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
	)	
Unlicensed Use of the 6 GHz Band	)	ET Docket No. 18-295
	)	
Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz	)	GN Docket No. 17-183
	)	

COMMENTS OF COMSEARCH

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SUMMARY

Comsearch supports efforts to create opportunities for unlicensed use of the 6 GHz band so long as there are adequate protections for incumbent users that allows for continuous interference free operation and growth for the many important services that rely on Part 101 microwave services. In support of such goals, the Commission should make sure that all unlicensed 6 GHz devices (both low-power indoors and outdoors) use a frequency coordination system, that the coordination system must be designed to effectively avoid interference with the primary microwave service licensees, and that no burden of interference avoidance or after-the-fact mitigation be placed on the incumbent point-to-point microwave users. Finally, it is critical that the coordination system must utilize an accurate and frequently updated database. Comsearch also provides guidance on specific technical parameters that could govern spectrum sharing, with particular attention to propagation loss modeling and interference protection criteria for exclusion zones.

With respect to the proposed Automated Frequency Coordination ("AFC") system, Comsearch agrees with the Commission's proposal that the AFC system should serve as the repository for unlicensed device registration data in the 6 GHz band and that AFC operators should maintain exclusion zones protecting incumbent microwave operations pursuant to the propagation modeling and IPC methodologies eventually adopted by the Commission. With respect to the AFC testing and certification process, Comsearch urges the Commission to seek separate comment via public notice after finalizing the rules for unlicensed 6 GHz operation, but anticipates that a happy medium can be struck between the relatively informal process used in the TV White Space context and the more elaborate requirements governing the CBRS band.

Finally, Comsearch notes that when interference occurs, licensed operators must be able to contact AFC operators and expect immediate, near real-time resolution. Finally, Comsearch suggests that many of the technical parameters necessary to effectuate an AFC system can be developed collaboratively in a multi-stakeholder group.

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COMMENTS OF COMSEARCH

Comsearch, a CommScope company,[1] hereby files its initial comments in the above-captioned proceeding. We believe coordinated control of all unlicensed devices in the 6 GHz band, particularly the U-NII-5 (5.925-6.425 GHz) and U-NII-7 (6.525-6.875 GHz) bands, is necessary to effectuate sharing in a way that provides reliable protection to fixed microwave incumbents while making available new spectrum opportunities for unlicensed users.

I. Comsearch's Unique Perspective

Comsearch (**www.comsearch.com**) has been a leading provider of spectrum management and wireless engineering products and services since 1977. As detailed below, we have developed industry-standard interference analysis and mitigation processes and procedures, we maintain state-of-the-art software and comprehensive databases used in the design of

[1] Comsearch is a business unit within the Integrated Solutions/CommScope Mobility Solutions division of CommScope (NASDAQ: COMM). CommScope helps companies around the world design, build and manage their wired and wireless networks. Our vast portfolio of network infrastructure includes some of the world's most robust and innovative wireless and fiber optic solutions. Our solutions can be found in the largest buildings, venues and outdoor spaces; in data centers and buildings of all shapes, sizes and complexity; at wireless cell sites; in telecom central offices and cable headends; in FTTx deployments; and in airports, trains, and tunnels.

complex wireless systems, and we are leading efforts to develop next-generation dynamic spectrum management capabilities.

For the past four decades, we have been the pre-eminent frequency coordinator for commercial microwave systems in the United States. Over just the last five years, we have coordinated and licensed thousands of microwave paths and tens of thousands of microwave frequencies. We have been gathering data for over 40 years on microwave and wireless networks from an abundance of sources. We verify, update, and manage our extensive databases daily, and have amassed one of the largest and most accurate private collections of engineering data in the telecommunications industry. On behalf of existing and prospective spectrum users, our engineers rely upon these databases to perform thousands of interference analyses and frequency assignments per month. Our databases contain complete data on telecommunications sites, antennas and patterns, radios and radio filter curves, and station owners, and comprise well over half a million records.[2]

Further, as demand for spectrum has increased, Comsearch has enabled innovation in wireless services by developing a broad range of dynamic sharing analysis capabilities and insight through our work as a TV White Space ("TVWS") Database Administrator and in the

[2] In addition to our frequency coordination efforts, we have developed numerous innovative software products and capabilities to address the engineering challenges of network planning, spectrum management, and spectrum administration. For example, along with Comsearch's work as a TV white spaces database administrator and CBRS SAS and ESC administrator, Comsearch acts as a 70-80-90 GHz Link Registration Database Administrator, the Wireless Medical Telemetry Service database manager on behalf of the American Hospital Association, the AWS Cost-sharing Clearinghouse manager on behalf of CTIA and has developed **iQ·linkXG**, a commercial software tool used in 29 countries that supports the complete analysis, frequency planning, and administration of terrestrial microwave networks.

Citizens Broadband Radio Service ("CBRS") as a Spectrum Access System ("SAS") and Environmental Sensing Capability ("ESC") administrator.

We believe our position as the premier frequency coordinator of fixed-service microwave systems, our development and management of comprehensive spectrum engineering databases, and our leadership in the latest, cutting-edge dynamic spectrum management technologies make us uniquely qualified to comment on the advantages and disadvantages of a range of frequency coordination and spectrum sharing approaches, including the proposed potential use of Automatic Frequency Coordination ("AFC"), as a means to permit unlicensed devices to share 6 GHz with point-to-point microwave services.

II. Carefully Designed Rules Could Enable Successful 6 GHz Spectrum Sharing

Comsearch supports the Commission's effort to find ways to create opportunities for new wireless services while ensuring that existing point to point services continue to operate and grow free from interference. As recognized in the NPRM, it is critical that rules permitting the introduction of new unlicensed services in the 6 GHz band, particularly the U-NII-5 (5.925-6.425 GHz) and the U-NII-7 band (6.525-6.875 GHz), which are heavily used for point-to-point links, and protect the important incumbent licensed services that operate and continue to grow in the 6 GHz spectrum.[3] While incumbent spectrum users have uniformly emphasized the need to protect incumbent operations, not all are confident that successful sharing mechanisms can be established.[4] We believe coordinated control of unlicensed devices in the U-NII-5 (5.925-6.425 GHz) and U-NII-7 6.525-6.875 GHz band is necessary to effectuate sharing in a way that

[3] *Unlicensed Use of the 6 GHz Band, et al.*, Notice of Proposed Rulemaking, FCC 18–147, para. 20 (rel. Oct. 24, 2018) ("*6 GHz Band NPRM*").

[4] *Id.*, para 16.

provides reliable protection to fixed microwave incumbents while making available new spectrum opportunities for unlicensed users.

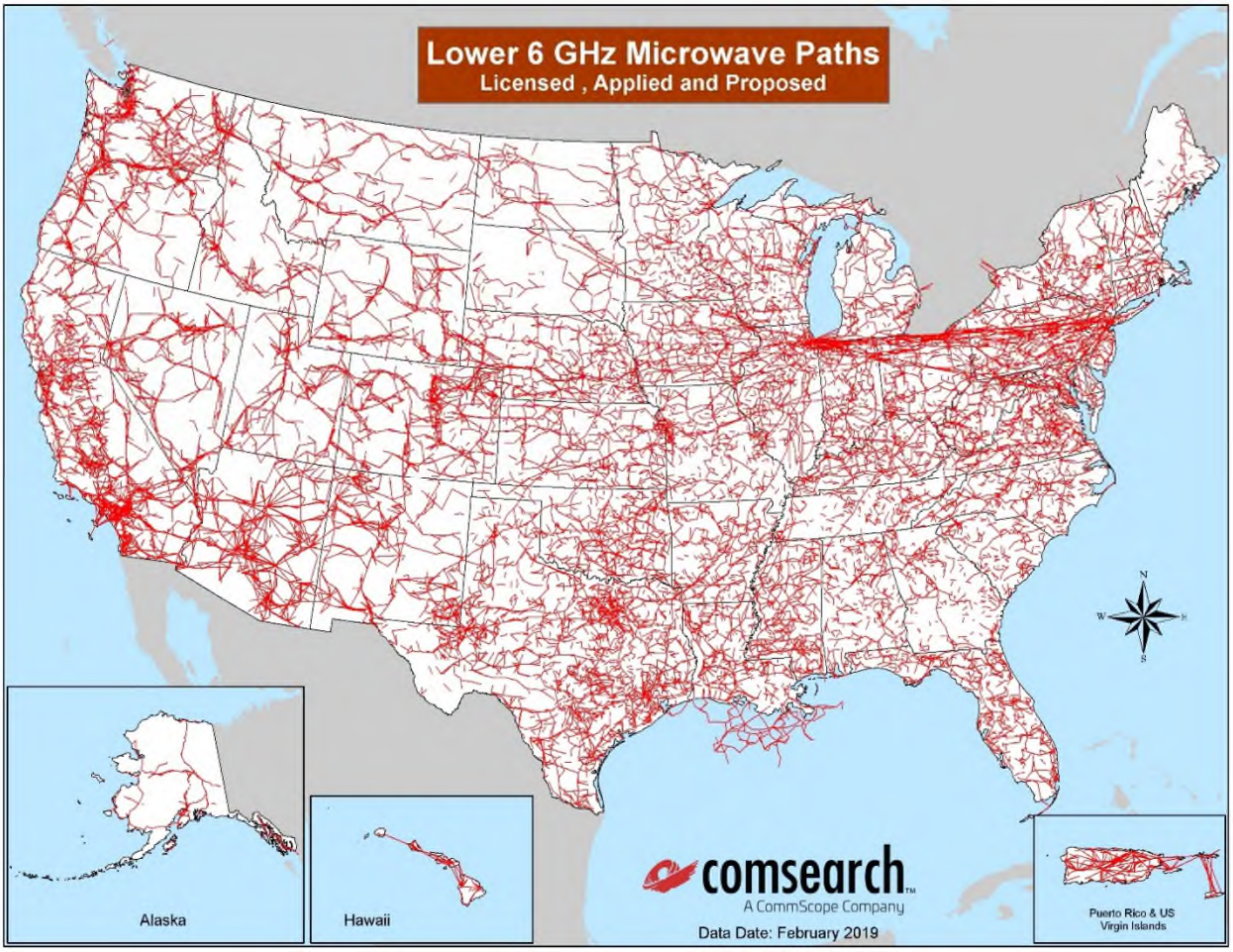
In considering whether and how new unlicensed devices could share 6 GHz spectrum with incumbent microwave services, Comsearch urges the Commission to weigh the following basic sharing principles:

- All unlicensed devices must use a coordination system to avoid interference with incumbent users.
- The coordination system must control transmissions by unlicensed devices that are co- or adjacent frequency to a microwave receiver
- The coordination system must be based on accurate database information and a conservative predictive method.
- Rules allowing the introduction of new services in the 6 GHz band must not place the burden on microwave licensees to monitor and track down sources of interference.

III. Protection of Microwave Incumbents Must be Based on a Robust, Well-Designed Frequency Coordination System that Effectively Limits the Risk of Interference to Incumbent Point-to-Point 6 GHz Band Microwave Users

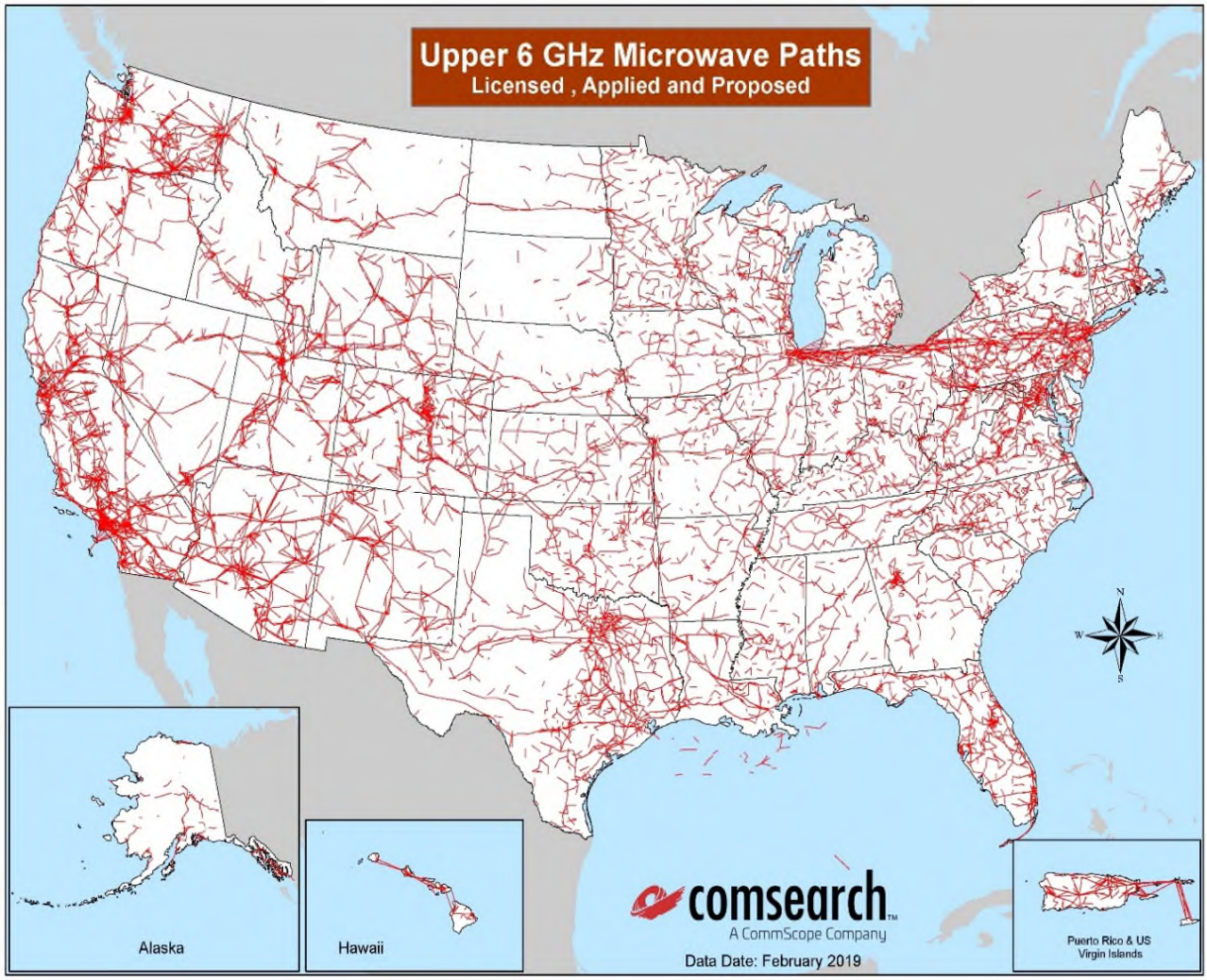
For decades, 6 GHz microwave services and facilities have served as a core communications infrastructure component of commercial, industrial, and public safety communications systems. Police, fire and rescue agencies, railroads, utilities, and telecommunications companies, among many others, heavily use 6 GHz links in their networks. Figures 1 and 2 below show plots of the microwave systems in both the lower 6 GHz band (5.925-6.425 GHz) and upper 6 GHz band (6.525-6.725 GHz) as well as the number of microwave paths and transmit frequencies in each band portion.

Figure 1: Plot of Microwave Paths in the Lower 6 GHz Band (5.925-6.425 GHz)



Paths	Transmit Frequencies
27,445	75,087

Figure 2: Plot of Microwave Paths in the Upper 6 GHz Band (6.525-6.725 GHz)



Paths	Transmit Frequencies
14,967	31,288

These figures show there are over 42,000 microwave paths using over 106,000 frequencies.

In addition to the substantial number of microwave paths and frequencies using the 6 GHz bands, we notice a trend of microwave systems using more spectrum per path. Analysis of our frequency data shows the average MHz per path in the U-NII-5 (5.925-6.425 GHz) over the ten years has grown from 66.5 MHz / path in 2008 to 105.1 MHz / path in 2018. We note that more paths are being coordinated and licensed for more than one channel and often for the full frequency block.

In order to protect incumbent users, the NPRM proposes a framework that would prohibit unlicensed devices operating co-channel with any fixed link in the 6 GHz band within that link's exclusion zone. The NPRM also proposes a frequency coordination process for unlicensed devices transmitting in the band to protect against interference to fixed service incumbents. Similar to the rules adopted for TVWS and CBRS, the NPRM proposes an automated coordination process by which a standard power access point would determine or receive a list of permissible frequencies and restrict operation to those frequencies.[5]

Comsearch strongly supports implementation of effective frequency coordination governing the introduction of any new service in the GHz band. The Commission's Part 101 prior frequency coordination rules have enabled commercial entities to make dense shared use of the spectrum with a high degree of confidence that important transmissions -- including many that are essential to health and human safety -- will be free from disruptive interference.[6] Frequency coordination procedures and FCC licensing have proven to be valuable tools to help with *ex ante* interference avoidance as well as *ex post* identification and mitigation of

5 *Id.*, para 23.
6 47 C.F.R. § 101 (2018).

interference. The AFC and other rules developed in this proceeding must be designed to provide proper protection for incumbent licensees from interference from unlicensed devices.[7]

A. All Unlicensed Device Operation in the 6 GHz Band Must Use AFC in Order to Prevent Interference in the Microwave Services

The NPRM seeks comment on whether the rules should allow indoor low power access point operations in the U-NII-5 and U-NII-7 bands without use of or need for authorization from an AFC.[8] While the Commission readily recognizes that the U-NII-5 and U-NII-7 bands are dominated by common carrier, public safety and critical infrastructure point-to-point microwave links[9], it gives credence to the view raised by unlicensed device interests that low power devices may operate indoors at power levels sufficiently low that they pose no material risk of harmful interference to incumbent links.[10] Comsearch strongly disagrees and urges the Commission to require *all* unlicensed devices operating in the U-NII-5 and U-NII-7 sub bands to use AFC.

As discussed in more detail below,[11] there is no assurance that unlicensed devices operating indoors will not interfere with microwave services. The rules that govern the introduction of new unlicensed devices in this band cannot leave interference protection of microwave services to chance. There are foreseeable circumstances in which unlicensed devices operating indoor could interfere with operating microwave services.[12]

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7 Prior coordination procedures have a long history of enabling successful frequency sharing among a wide variety of services. In particular, coordination procedures have been tailored to address the specific challenges presented by sharing in the point to point microwave services, Advanced Wireless Services ("AWS"), 70-90 GHz, Wireless medical telemetry service, TV White Spaces and most recently, the Citizen Band Radio Service ("CBRS").

8 *6 GHz Band NPRM,* para 73.

9 *Id.*, paras 9, 73 and Appendix A.

10 *Id.*, para 73.

11 See discussion and examples at Sections III(A) and (B).

12 *Ex Parte* Letter from Catherine Wang, Morgan, Lewis & Bockius LLP to Marlene Dortch, Secretary, GN Docket No. 17-183, at 1 (filed Aug. 24, 2018). ("Comsearch Aug. 24 Ex Parte").

i. Comsearch Spectrum Availability Simulation

Appendix A presents an analysis of interference potential from low-power indoor (LPI) devices into microwave receivers. Comsearch conducted a simulation of interference potential from randomly-placed LPI devices into licensed microwave systems operating in the U-NII-5 band. Using actual data from our frequency coordination databases, plus parameters suggested in a study filed with the Commission by unlicensed proponents[13], we conducted Monte Carlo simulations of interference potential from a statistical deployment of LPI devices in the Dallas, TX area. Dallas was selected since it represents a typical distribution of fixed microwave systems in a Top 10 urban area with relatively flat terrain. Dallas also has the most 6 GHz microwave paths within 50 miles of the urban center than any other Top 10 urban area as shown **Table 1** below.

[13] *Ex Parte* Letter from Paul Margie, Harris Wiltshire & Grannis LLP, Counsel to Apple Inc., Broadcom Corporation, et al. to Marlene Dortch, Secretary (filed Jan. 25, 2018), (RKF Study).

Table 1 -
Number of Microwave Paths Within 50 Miles of Top 10 Urban Areas in the Lower 6 GHz band

	Market	Latitude	Longitude	Lower 6 GHz band Licensed/Applied path count within 50 miles
1	New York	40.7128° N	74.0060° W	266
2	Los Angeles	34.0522° N	118.2437° W	272
3	Chicago	41.8781° N	87.6298° W	246
4	Philadelphia	39.9526° N	75.1652° W	253
5	Detroit	42.3314° N	83.0458° W	61
6	Boston	42.3601° N	71.0589° W	66
7	San Francisco	37.7749° N	122.4194° W	160
8	Washington	38.9072° N	77.0369° W	251
9	**Dallas**	**32.7767° N**	**96.7970° W**	**292**
10	Houston	29.7604° N	95.3698° W	241

Figure 3 and 4 below show respectively plots of the microwave paths and associated microwave receivers within 50 miles of the center of Dallas.

Figure 3: Microwave Paths Within 50 miles of Dallas, TX

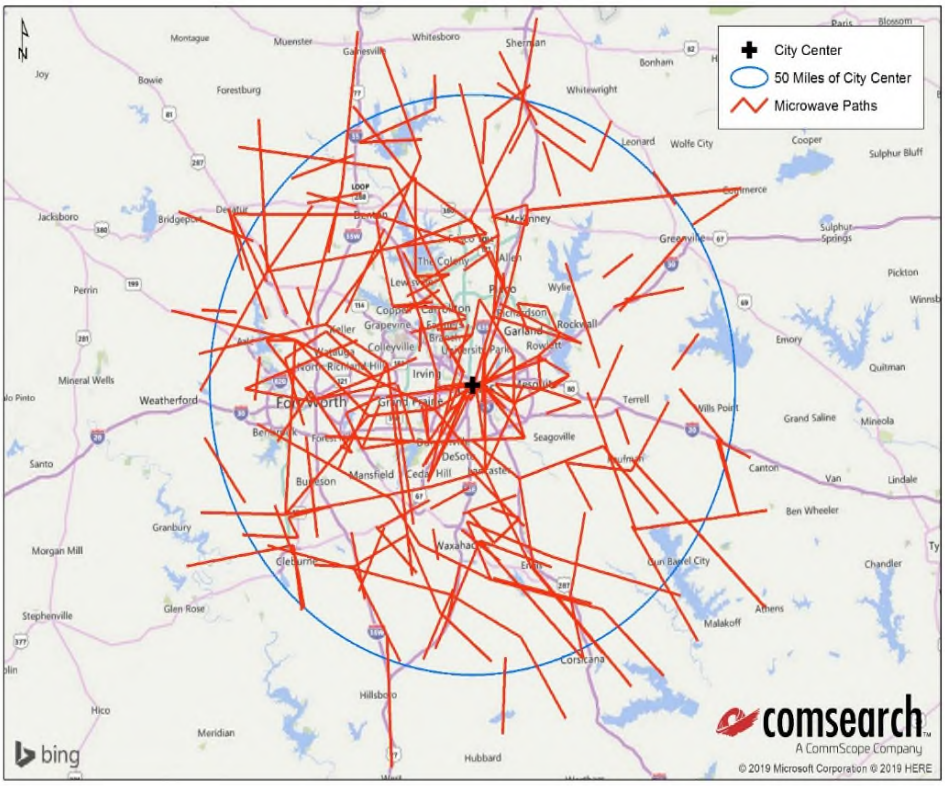
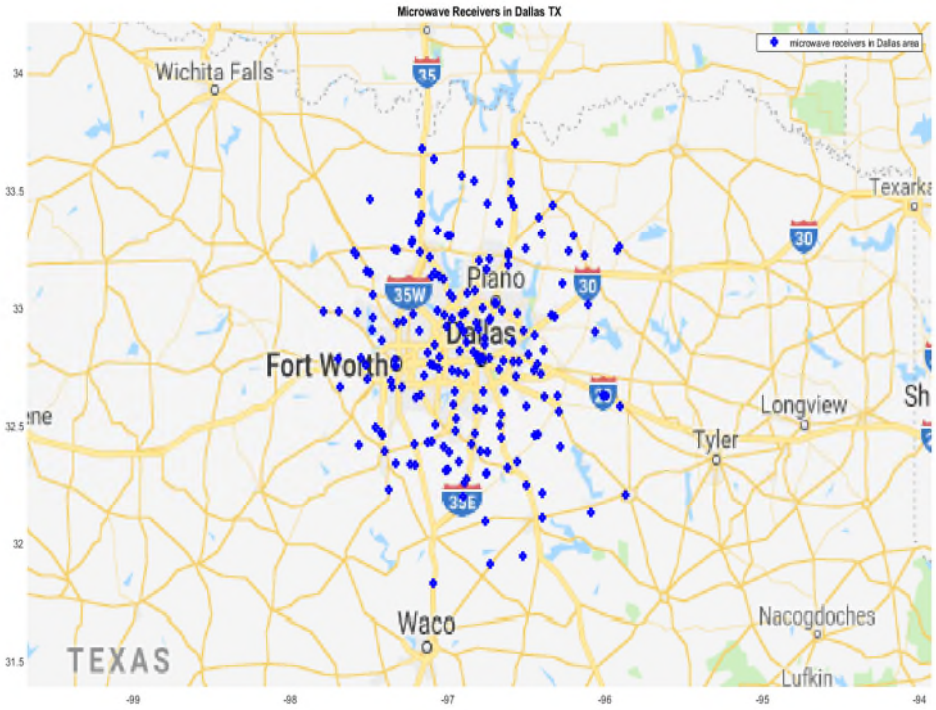


Figure 4: Microwave Receivers Within 50 miles of Dallas, TX



Figures 5 and 6 below show spectrum availability in Dallas for LPI devices based on 80 MHz channels.

Figure 5: Spectrum Availability in Dallas, TX for Low-Power Indoor Devices Based On 80 MHz Channels

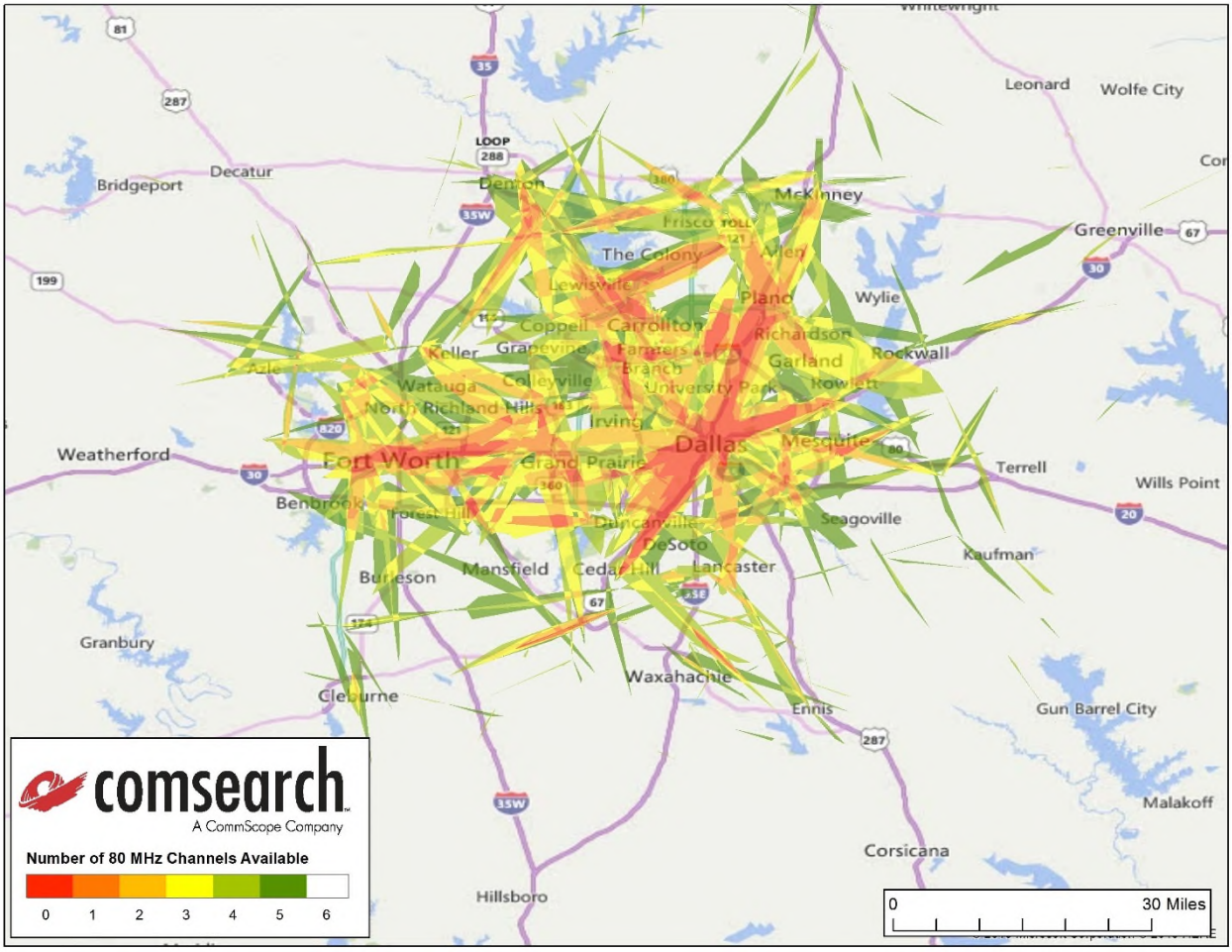
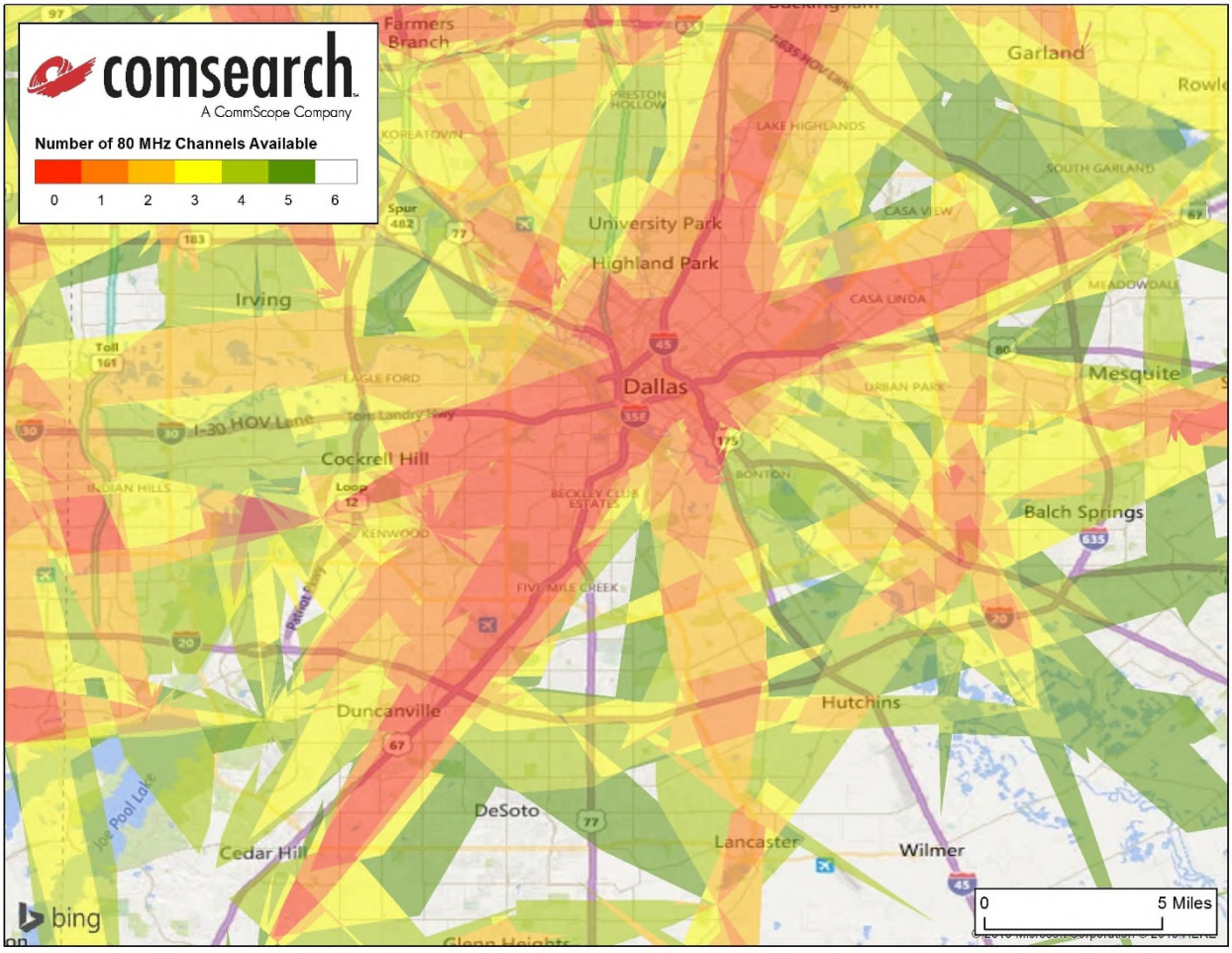


Figure 6: Localized Area of Spectrum Availability in Dallas, TX for Low-Power Indoor Devices Based On 80 MHz Channels



Results of the simulations as shown in Figures 5 and 6, and detailed in Appendix 1, indicate that there are locations where low-power indoor device deployment could cause interference into licensed microwave receivers across the entire U-NII-5 (5.295-6.425 GHz) band in Dallas, TX. This is shown in the red areas depicted in the figures. It is also important to note the figures also show that there is a high likelihood for co-channel interference from LPI devices into practically all of the microwave links in the study set.[14] As new microwave paths continue to be deployed in the 6 GHz band at an average rate of several hundred per month, the interference potential will only increase.

Therefore, Comsearch strongly suggests that the Commission require all unlicensed devices operating in the 6 GHz band to use an AFC in order to prevent interference into licensed incumbent microwave services.[15]

ii. Incumbent Microwave Licensees Should Not Be Required to Identify and Mitigate Interference from Unlicensed Devices

The rules should not place the burden on incumbent microwave providers to mitigate interference from such devices after interference has occurred. As a policy matter, microwave operators licensed under Part 101 are the *primary* service licensees and it is the regulatory responsibility of the unlicensed device to avoid interference. Microwave operators will not be in a position to identify sources of interference, contact responsible parties, and assure that interference has been mitigated.[16] Determination that a receiver is being degraded by interference requires the link to be taken out of service for a measurement, and intermittent interference may not even be present during the measurement. If degradation is recognized,

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[14] We note that the results of any study of interference are subject to the analysis parameters. While we believe the results depicted here are accurate for the analysis parameters applied, we suggest more study and agreement is needed on appropriate analysis parameters required to characterize the interference potential of unlicensed devices into microwave receivers. We intend to perform additional analyses.

[15] Comsearch further suggests that the Commission should seek measurement data to support any claim of non-interference (or interference). We expect to perform such measurements and will submit results on this docket.

[16] See FWCC July 17, 2018 ex parte, "FS operator cannot detect interference until after link fails. Even then cannot tell if failure was due to deep fade, RLAN interference, or something else. FS cannot decode RLAN's ID information."

finding the source(s) could require an area search with direction-finding equipment. Such efforts are utterly impractical and microwave licensees may not reasonably be expected to take on the costs. The rules should be structured as much as possible to avoid interference with incumbent microwave services *in the first place*. The record is replete with information of the many critical services and applications – including public safety and health services -- that rely on interference-free microwave transmissions that cannot be left vulnerable to interference from new unlicensed devices operating in the 6 GHz band.[17] Rules that address interference protection only *after* the fact fall short of adequate interference protection and would not serve the public interest.

B. Data on Incumbent Systems Must Be Accurate and Complete

The NPRM proposes that unlicensed devices seeking to transmit at a particular location be required to obtain a list of permissible frequencies from an AFC system prior to transmitting.[18]

The Commission's record shows (and our experience concurs) that new methods to effect dynamic spectrum sharing are feasible but must be crafted and continually managed to provide utmost protection for licensed incumbents. In that respect, any AFC system must:

- Use accurate and frequently-updated data on incumbent systems and their respective configurations,
- Incorporate mutually-agreeable technical parameters and methods for protecting licensed incumbents,
- Be able to accommodate uncertainties in unlicensed device location reporting, including device height,
- Implement interference detection and mitigation that places absolutely no burden on licensed incumbents,
- Facilitate immediate device disablement upon determination of harmful interference,

[17] *C.f.* Comments of the Fixed Wireless Communications Coalition at 1-8 Docket No. 17-183 (arguing that safety of life operations in the 6 GHz band would require extremely robust frequency coordination systems before sharing would be possible).

[18] *6 GHz Band NPRM,* para. 25.

- Incorporate reliable system security,
- Be tested and FCC-certified through a quick, yet thorough process.

The NPRM proposes that coordination through the AFC be accomplished by relying on the Commission's ULS license database.[19] In handling countless frequency coordinations for point-to-point microwave facilities over the past several decades, Comsearch can attest to the extensive and highly dynamic nature of microwave operations and related licensing in the 6 GHz band and the limitations of the Commission's ULS database. FCC licensing and the prior frequency coordinations that make licensing possible are in high demand and constantly changing. **Table 2** below shows all 6 GHz frequency coordination and filing activity from 2013-2018.

Table 2: 6 GHz Coordination & Filing Activity 2013-2018

	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**Average per Month/Day**
Filing (sites)	8815	7620	6848	7604	7245	7200	631/21
Coordinations (links)	6649	6033	5469	5459	5520	5150	476/16

This highly dynamic environment presents a challenge to ensuring that all spectrum users, existing and prospective, can rely on accurate data reflecting the location and technical parameters of primary microwave user systems. Accurate data – up to date and complete – is critical to enabling robust deployment of unlicensed devices while avoiding interference to primary spectrum users. As a leading coordinator, Comsearch has every incentive to use -- and does use -- the ULS to the fullest extent possible. However, in our extensive experience in this

[19] *Id.*, para 39.

area, the Commission's ULS-primarily an administrative rather than a technical database- is of limited utility in informing interference analysis necessary to allow additional use in the band by new or expanding microwave service users or unlicensed devices as new entrants in the spectrum. In particular:

- The Part 101 prior frequency coordination process accommodates identifies proposed operation of microwave links well before data shows up in ULS.
- Depending upon when the ULS is checked, a microwave path could be put into service under a conditional license at any time upon application submittal.
- The sheer level of microwave filing and coordination activity is sufficiently high to require frequent (at least daily) checks (ULS is updated during an overnight recycle.)
- Data in ULS is incomplete, sometimes inaccurate, and not sufficient for AFC use necessary to protect primary microwave users.
    - Does not include antenna parameters (model only)
    - Does not include information on radios
    - Contains errors
- The ULS is subject to procedures and policies that undermine database reliability. For example, as seen during the latest government shutdown, no license or equipment data was updated in the ULS during the majority of the shutdown period, yet new microwave paths were allowed to use conditional authorizations and initiate service upon application submittal. If the AFC system were operational and relying on the ULS, it would be missing this information and unlicensed device interference to microwave services would have been highly likely.

Comsearch notes that while Part 101 licensees have an incentive to submit accurate data, most of these issues noted above are outside the control of microwave licensees.

In light of the limitations of the ULS database, Comsearch strongly recommends that the rules should allow the use of databases that incorporate the data elements in ULS plus commercially developed enhancements that allow the AFC to function efficiently.

IV. Technical Parameters

The Commission seeks comment on technical service rules proposed to facilitate shared use of the 6 GHz band on an unlicensed basis while ensuring that longstanding, licensed incumbent services receive comprehensive interference protection.[20] As discussed above in Section I, having spent decades coordinating FS and FSS systems in the 6 GHz band, Comsearch profoundly appreciates that the band serves a critical and irreplaceable role in our national communications infrastructure, delivering voice, video and data content to hundreds of millions of Americans in perpetuity 24-hours per day. We support the Commission's commitment to adopt technical service rules for unlicensed U-NII service that thoroughly protect incumbent licensed users.[21]

Comsearch provides guidance on specific technical service rules and parameters below.

A. Propagation Loss Modeling for Exclusion Zone Determination

The Commission requests comment on different propagation model strategies for U-NII signals that, when married with appropriate interference protection criteria ("IPC") for fixed service incumbent use, will establish the size of the exclusion zone necessary to protect the incumbent from interference.[22] More specifically, the Commission seeks comment on a proposed propagation model that within the first kilometer of a U-NII transmitter would consider clutter loss in both line-of-sight ("LoS") and non-line-of-sight ("NLoS") conditions, and beyond the first kilometer would involve a combination of a terrain-based path loss model and a clutter loss model appropriate for the environment.[23] Thereafter, the Commission asks for feedback on

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[20] *See Id.*, para 77.

[21] Comsearch was formed and began coordinating common carrier FS and FSS services in the 6 GHz band in 1977.

[22] *6 GHz NPRM*, paras. 37, 48, 49.

[23] *See Id.*, para 49.

a specific hybrid WINNER II propagation model that combines LoS and NLoS in a single urban/suburban model, and separate comment on a proposal that aggregates and employs alternative propagation models depending on range.[24]

At this early juncture in the proceeding, with important technical service rules that may materially affect the predictability of U-NII signal propagation in the 6 GHz (location accuracy, AFC updates, etc.) still fluid, Comsearch cannot endorse a particular propagation model. Comsearch will revisit and make recommendations on specific propagation models as the proceeding moves forward. In the interim, Comsearch urges the Commission to carefully consider the following general recommendations regarding propagation modeling and exclusion zone calculations as the record continues to develop.

First, the ultimate propagation model (or amalgamation of models) adopted to facilitate shared use of the 6 GHz should accommodate flexible unlicensed device deployment scenarios (*e.g.*, in or above clutter, beyond line-of-sight, etc.), as well as a range of potential real-world interference scenarios (*e.g.*, aggregate interference from concurrently transmitting multiple U-NII devices). Accordingly, Comsearch appreciates the Commission's preliminary efforts to evaluate propagation models that take into consideration real-world variables (*e.g.*, varying distances between interfering and victim receiver and terrain-based path loss). The ultimate propagation model(s) adopted in the 6 GHz band and implemented by the AFCs managing future U-NII devices must be able to accurately evaluate what will be a dynamically changing RF environment. Based on our extensive experience implementing geolocation database technology in other bands,[25] however, we remain cautiously optimistic that the Commission will be able to

[24] *See Id.*

[25] Comsearch is a first wave Spectrum Access System administrator in the 3.5 GHz Citizens Broadband Radio Service, a TVWS database administrator, and a longstanding database administrator in the 70/80/90 GHz millimeter wave bands.

work with capable AFCs that can implement the more complex, demanding propagation models ultimately required to make shared use of the 6 GHz possible.

Second, building penetration loss assumptions must be agreed upon by all stakeholders with respect to any eventual propagation model. Nonetheless, actual scenarios will arise where propagation from unlicensed devices operating in buildings will undergo negligible attenuation.[26] For example, antennas may be directed towards apartment buildings where open patio doors could present almost no penetration loss.

B. Microwave Receiver Fade Margin

The Commission Seeks comment on "the typical design criteria for fixed service station fade margins."[27] As other involved parties have explained, fading in the 6 GHz occurs due to changes in temperature or humidity at different atmospheric elevations that refract directed signals toward a receiving antenna, which results in a longer path for the refracted signal, out-of-phase reception of the refracted signal, and partial cancellation of the direct signal.[28] Fading is a natural, reoccurring phenomenon that requires an extra reserve of signal power to compensate for the loss due to the refracted, unintentional signal. Fade margin is the difference between the received signal level in normal conditions and the minimum usable signal (threshold) under faded conditions. Microwave path design involves modeling the multipath fading process to determine the fade margin necessary to ensure operational availability at a certain objective. An objective of 99.999% availability is common while some services may require 99.9999% or better. Microwave users buy sufficient link fade margin by spending on, for example,

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[26] Comsearch Aug. 24 Ex Parte, at 1.

[27] *6 GHz Band NPRM*, para. 45.

[28] *Ex Parte* Letter from Mitchell Lazarus, Fletcher Heald & Hildreth, P.L.C. Counsel for Fixed Wireless Communications Coalition, Inc. ("FWCC"), to Marlene Dortch, Secretary, Docket No. 17-183, (filed March 13, 2018) (responding on behalf of the FWCC to the "Frequency Sharing for Radio Local Area Networks in the 6 GHz Band" study prepared by RKF Engineering Services, LLC) ("*FWCC Response*").

transmitters of high enough power, antennas of large enough size and high quality, and well-filtered and low noise receivers. Our data on 6 GHz digital receiver fade margins from 2018 showed a mean of 38 dB with 90% in the range 30 to 46 dB. We believe that in most cases these margins align with the link availability requirements.

C. Interference Protection Criteria (IPC) for Exclusion Zone Determination

The Commission separately seeks comment on IPC metrics to partner with the ultimate propagation model methodology discussed above to determine the exclusion zone around incumbent fixed services.[29] The Commission seeks comment on whether the "ratio of interference to noise power ("I/N ratio") or the ratio of the carrier to interference power ("C/I ratio")" are appropriate IPC metrics.[30] The Commission also seeks general comment on whether other metrics might be useful for specifying IPC, and requests feedback on the respective costs and benefits any proposed IPC metrics.[31]

With respect to IPC metrics, Comsearch offers general feedback at this early stage of the proceeding.

First, Comsearch recommends that the fundamental IPC should be an I/N ratio. For example, I/N = -6 dB limits interference degradation to 1 dB, often considered a negligible amount. Such a criterion protects the full fade margin per each link setup. However, if the Commission determines it is possible to permit greater interference to receivers that may have extra margin, a C/I criterion could be used for each receiver to preserve a fade margin needed for high availability. For example, Comsearch supposes that degradation of predicted availability to 99.9999% in multipath fading would not be objectionable.

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29 *See 6 GHz Band NPRM*, para 37.
30 *Id.*, para 42.
31 *See Id.*

Second, the ultimate IPC (regardless of its underlying metrics) must take into consideration the aggregative effects of multiple unlicensed devices. The principal example of an IPC implementation in the *Notice* only contemplates a single unlicensed transmitter.[32] In a real world deployment there may be many unlicensed U-NII devices operating in close proximity to fixed service microwave receivers, and implementing an IPC that evaluates these interfering signals in isolation could result in aggregate levels of interference that would render the 6 GHz band unusable. An effective IPC also needs to include and aggregate the interference that enters microwave receivers from adjacent-channel unlicensed devices.

Ultimately, any IPC adopted and implemented by the FCC must sufficiently protect licensed incumbents and ensure a level of reliability equivalent to well-engineered microwave link designed for implementation under the current service rules and radiofrequency environment.

D. Automated Frequency Coordination Administrator Implementation

The *Notice* requests further input on the implementation and performance of AFC operators that will ultimately authorize unlicensed device operations in the 6 GHz band.[33] Comsearch provides initial recommendations on AFC implementation below, based on our extensive experience and success developing geolocation database and dynamic spectrum sharing technologies.[34]

Fundamental AFC Responsibilities. Comsearch agrees with the Commission's proposal that AFC operators should serve as the repository for unlicensed device registration data in the 6 GHz band and maintain exclusion zones protecting incumbent microwave operations pursuant to

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[32] *See Id.*, para 33.

[33] See *Id.*, paras, 19, 20, 23, 37, 40.

the propagation modeling and IPC methodologies eventually adopted by the Commission (as discussed above in Sections C.[35] Specifically, AFC operators should use information collected during U-NII device registration and/or follow-on queries to implement exclusion zone contours and convey available frequencies, power levels and other relevant operating parameters back to the U-NII device. U-NII devices should then report actual operating frequency information back to the AFC, which will maintain this information for the purpose of interference detection and mitigation. AFC operators should have "kill switch" authority, enabling the AFC to "push" a command to mute transmission to an unlicensed device during an interference event, or to disable unlicensed devices at routine query intervals.[36] Finally, Comsearch urges the Commission to require AFC registration for both standard-power ***and*** low-power unlicensed devices. There are many real-world scenarios where a low-power device may create interference by itself or through a contribution to aggregate co-channel or adjacent channel interference. Comsearch has performed countless interference identification measurements across most of the commercial spectrum bands and have found interference from myriad devices and sources. Accordingly, limiting AFC oversight solely to the standard-power variety of proposed U-NII device offers inadequate protection, and there is no valid technical or policy reason not to extend AFC oversight to low-power devices.

AFC Certification, Testing & Security. The Commission seeks comment on the certification process for AFC operators, requesting input on the appropriate role of the Office of Engineering and Technology ("OET"), the possibility of delegating certification to a third party,

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[35] *6 GHz NPRM*, para. 33.

[36] *See* 47 C.F.R. § 96.39(c)(2), requiring CBRS transmitters to "cease transmission, move to another frequency range, or change its power level within 60 seconds as instructed by an SAS."

and the value of a multi-stakeholder group in the oversight of AFC administration.[37] With respect to AFC certification and testing issues, Comsearch offers the following recommendations.

All AFC operators must be FCC tested and certified. Comsearch does not oppose the use of an independent test lab to perform testing, but the FCC must exercise oversight, and stakeholders must be able to participate in the selection process for the test labs. With respect to the testing and certification process, Comsearch urges the Commission to seek separate comment through a public notice after rules for unlicensed 6 GHz operation have been finalized, but anticipates that a happy medium can be struck between the relatively informal test/certification process used to approve TV White Space database administrators (informal testing by a handful of FCC staff followed by a short public trial and feedback from third parties that attempted to register TV stations and/or Part 74 auxiliary devices for protection), and the elaborate and still ongoing process used to test and certify CBRS Spectrum Access System ("SAS") administrators (entry into a voluminous Cooperative Research and Development Agreement with the National Telecommunications and Information Administration followed by certification testing at NTIA laboratory facilities in Boulder, CO and an eventual public trial).

Comsearch agrees that standard security protections applicable to other Part 15 devices (e.g., 5 GHz Dynamic Frequency Sharing transmitters) should extend and apply to all U-NII unlicensed devices in the 6 GHz. In short, equipment manufacturers and/or importers must ensure that firmware capable of changing the operating parameters of the unlicensed device,

[37] *See 6 GHz NPRM*, para 34.

including its interactions with an AFC, cannot be modified or altered by an unauthorized third party.[38]

Comsearch agrees that a *bona fide* and neutral multi-stakeholder group with the proper mandate to develop and promulgate the necessary standards, recommendations and guidelines will help ensure that the AFC is developed and managed more quickly and efficiently than if left *per se* to industry participants. A multi-stakeholder group should be able to ensure full participation among all participants and establish a broad and inclusive framework for collaboration.[39] Comsearch would endorse the WInnForum as one such multi-stakeholder group that should be given consideration given its experience leading the development of standards and guidelines related to CBRS SASs.[40]

AFC Certification, Testing & Security. The Commission proposes to select multiple AFC operators and to permit AFC operators that conclude certification and deploy systems to compete with each other and collect fees for device registration and value added services.[41] Comsearch agrees that the Commission should solicit multiple proposals for AFC operators and allow such systems to compete against each other. This approach is consistent to the Commission's successful deployment of geolocation database technology in the TV White Spaces and CBRS.

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[38] See, e.g., 47 C.F.R. §15.407(i)(1), which requires Dynamic Frequency Selection U-NII 5 GHz devices to "contain security features to protect against modification of software by unauthorized parties."

[39] Topics that a multi-stakeholder group could address include: propagation models, interference protection criteria, AFC framework, security, sharing framework and criteria, collaborative testing, interference determination, reporting and mitigation. Moreover, interference resolution processes can be developed collaboratively among stakeholders within a multi-stakeholder group. *See 6 GHz NPRM*, para 34.

[40] The Wireless Innovation Forum ("WInnForum") is "dedicated to advancing technologies supporting the innovative utilization of spectrum and the development of wireless communications systems, including essential or critical communications systems. Through events, committee projects and initiatives the Forum acts as the premier venue for its members to collaborate to achieve these objectives, providing opportunities to network with customers, partners and competitors, educate decision makers, develop and expand markets and advance relevant technologies." https://www.wirelessinnovation.org/

[41] *See 6 GHz Band NPRM*, para. 33.

Comsearch also recommends that devices should communicate with all AFCs and all AFCs should be required to perform all functions. This will simplify the ecosystem and certification process. AFC operators should also operate autonomously. As currently envisioned, we see no need to share data across multiple AFC operators assuming we can develop any easy method to allow licensed incumbents to report interference and have it mitigated[42].

Comsearch also supports the Commission's proposal to permit AFC operators to collect fees. Experience has shown that market forces will keep fees reasonable, and AFC operators should be able to establish whatever fee structure they like.

Device Location Accuracy. An approved AFC must account for unlicensed device location uncertainty by assuming worst-case location configuration with respect to the affected microwave receiver as depicted below in Figure 7.

[42] Our experiences with TVWS and CBRS indicate that sharing data among all AFC operators will facilitate interference identification for incumbents since any AFC operator would be able to identify operating unlicensed frequencies when queried. We note that SAS operators are currently working with the FCC to develop a process for interference identification and mitigation, and the results of these efforts could inform the AFC process.

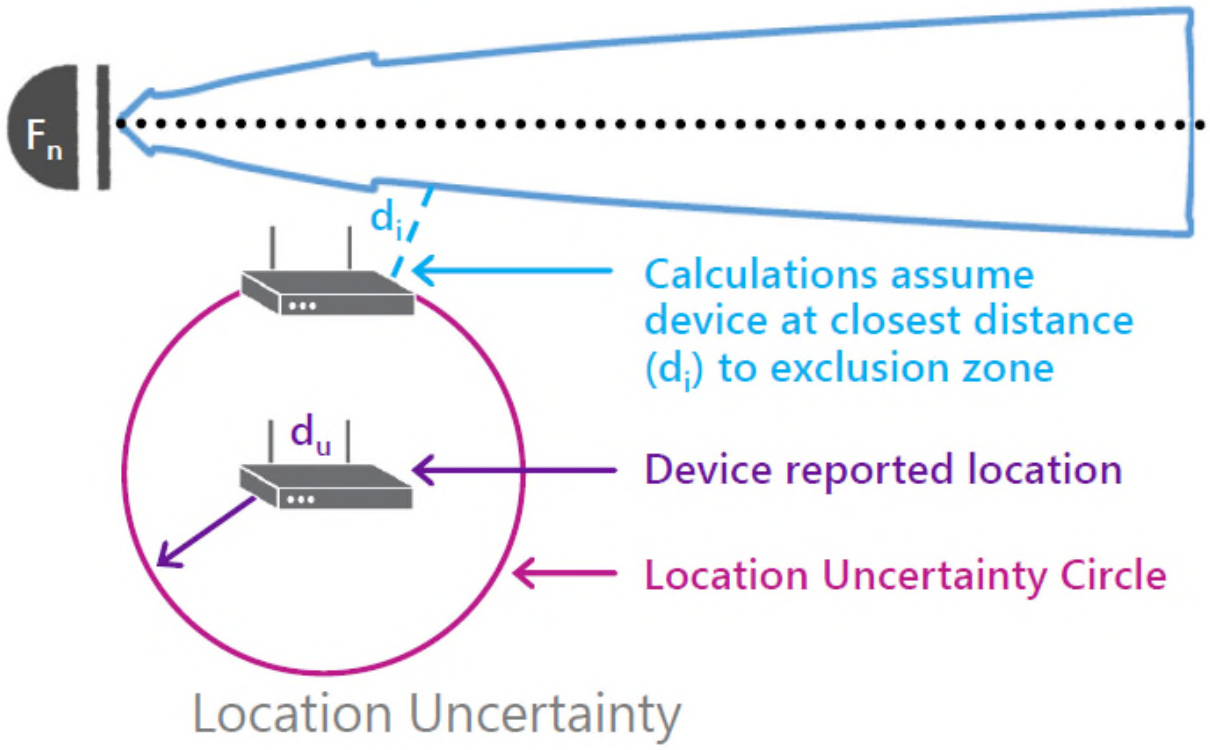

Figure 7: Device Location Uncertainty

Each unlicensed device must be able to determine the accuracy of its position. This location accuracy would be used to determine the worst-case position of the unlicensed device with respect to the microwave receiver exclusion zone.

AFC Interference Resolution. When interference occurs, licensed operators must be able to contact AFC operators and expect immediate, near real-time resolution. At a minimum, licensed microwave operators should have the same expectation of protection as incumbents in other bands have where dynamic spectrum sharing has been implemented.[43] Accordingly, Comsearch agrees with the Commission's proposal that AFCs should collect, store and make

[43] *Unlicensed Operation in the TV Broadcast Bands*, FCC 08-260, Second Report and Order and Memorandum Opinion and Order, para. 212 (2008), 47 C.F.R. §15.715(k); 47 C.F.R. § 96.55(m), *In the Matter of Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Report and Order and Second Further Notice of Proposed Rulemaking, FCC 15-47, paras. 235, 349 (2015).

available data on frequencies in use by standard-power unlicensed device access points to facilitate resolution of interference complaints.[44]

Comsearch offers specific recommendations for AFC technical parameters and implementation in **Table** 3 attached.

Respectfully submitted,

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_____

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[44] *See 6 GHz Band NPRM*, para. 89.

ATTACHMENT A

Table 3 **Automatic Frequency Coordination Operational Recommendations**	
AFC Exclusion Zone Implementation	Comsearch recommends that authorized AFC operators render and thereafter maintain exclusion zones around licensed microwave receivers pursuant to: (a) Implementation of approved and adopted propagation models. (b) Assumption of typical RLAN device configurations with factors to accommodate • Duty cycles • Range of unlicensed device heights and transmit powers,[45] • Interference protection criteria that calculates aggregated interfering signals. (c) Actual microwave receiver configurations from databases.
Unlicensed Device AFC Registration	Comsearch recommends all unlicensed devices register with an FCC certified AFC.[46] Registration information should include: • FCC ID • Manufacturer's serial # • Location information (Lat/Lon) • Indoor/Outdoor • Height AGL • Name & contact information of person responsible for device's operation
Unlicensed Device AFC Query	Registration and query may occur at the same time, so initial query request could contain registration information. Subsequent query requests would contain: • Location information • Height • Device ID or serial number
	Comsearch recommends unlicensed devices recheck or re-query an AFC accordingly:

[45] Assumptions on RLAN deployment would be consistent with TV White Space rules. *See* 47 CFR §15.712.

[46] Requiring unlicensed device end user registration with a geolocation database is consistent with FCC action in the TV White Spaces and CBRS. *Unlicensed Operation in the TV Broadcast Bands*, FCC 08-260, Second Report and Order and Memorandum Opinion and Order, para. 90.

Table 3 **Automatic Frequency Coordination Operational Recommendations**	
Unlicensed Device AFC Recheck/Re-query	• Daily (accommodates dynamic nature of microwave coordination and licensing and allows for 24 hours max to disable interfering device); • Whenever an unlicensed device moves beyond its uncertainty sphere (new geometry means new interference parameters). see Figure 8). Whenever an unlicensed device powers on.

APPENDIX A

Sharing in the 6 GHz Band
by Unlicensed Low-power Indoor Devices

Introduction

The 6 GHz Notice of Proposed Rulemaking (NPRM) asks whether the Commission should allow sharing of the U-NII-5 and -7 bands (5925-6425 MHz and 6525-6875 MHz respectively) by low- power indoor (LPI) devices without the need for authorization from an automatic frequency coordination (AFC) system.[47] The Commission asks commenters to provide detailed analysis to support their position regarding whether such operation should or should not be permitted.[48]

Comsearch has performed this simulation analysis to determine the potential for harmful interference from such LPI devices into licensed fixed service (FS) microwave systems operating in the U-NII-5 band. Using actual data from our frequency coordination databases, plus parameters suggested in a study filed with the Commission by unlicensed proponents[49], we conducted Monte Carlo simulations of interference potential from a statistical deployment of LPI devices in the Dallas, TX area. Dallas was selected since it represents a typical distribution of fixed microwave systems in a Top 10 urban area with relatively flat terrain.

We note that the results of any study of interference are subject to the analysis parameters. While we believe the results depicted here are accurate for the analysis parameters applied, we suggest more study and agreement is needed on appropriate analysis parameters required to characterize the interference potential of unlicensed devices into microwave receivers. We intend to perform additional analyses as mentioned in the Observations section.

We expect these results could be extensible to fixed microwave systems operating across the entire 6 GHz band (5925-7125 MHz).

Simulation Methodology

Using the Comsearch databases containing extensive data on FS microwave systems, we selected microwave links in the U-NII-5 band where at least one end was within 50 miles of the center of Dallas.[50] This totaled 292 links. A plot of these links is shown in Figure 1. We then identified the receivers associated with these links, which is shown in Figure 2.

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[47] FCC 18-147, *Unlicensed Use of the 6 GHz Band; Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz* (rel. Oct. 24, 2018) (NPRM) at ¶73.
[48] *Id.*
[49] Apple Inc., Broadcom Corporation, et al. Jan. 25, 2018 *Ex Parte,* (RKF Study)
[50] According to Microsoft Bing, these coordinates are: 96°48'27.896"W , 32°46'58.442"N.

A substantial portion of the chosen area is dense urban and suburban with some surrounding rural areas.

Key FS microwave elements of this data used for this analysis include the following: site location, antenna heights, antenna azimuth, and actual antenna pattern.

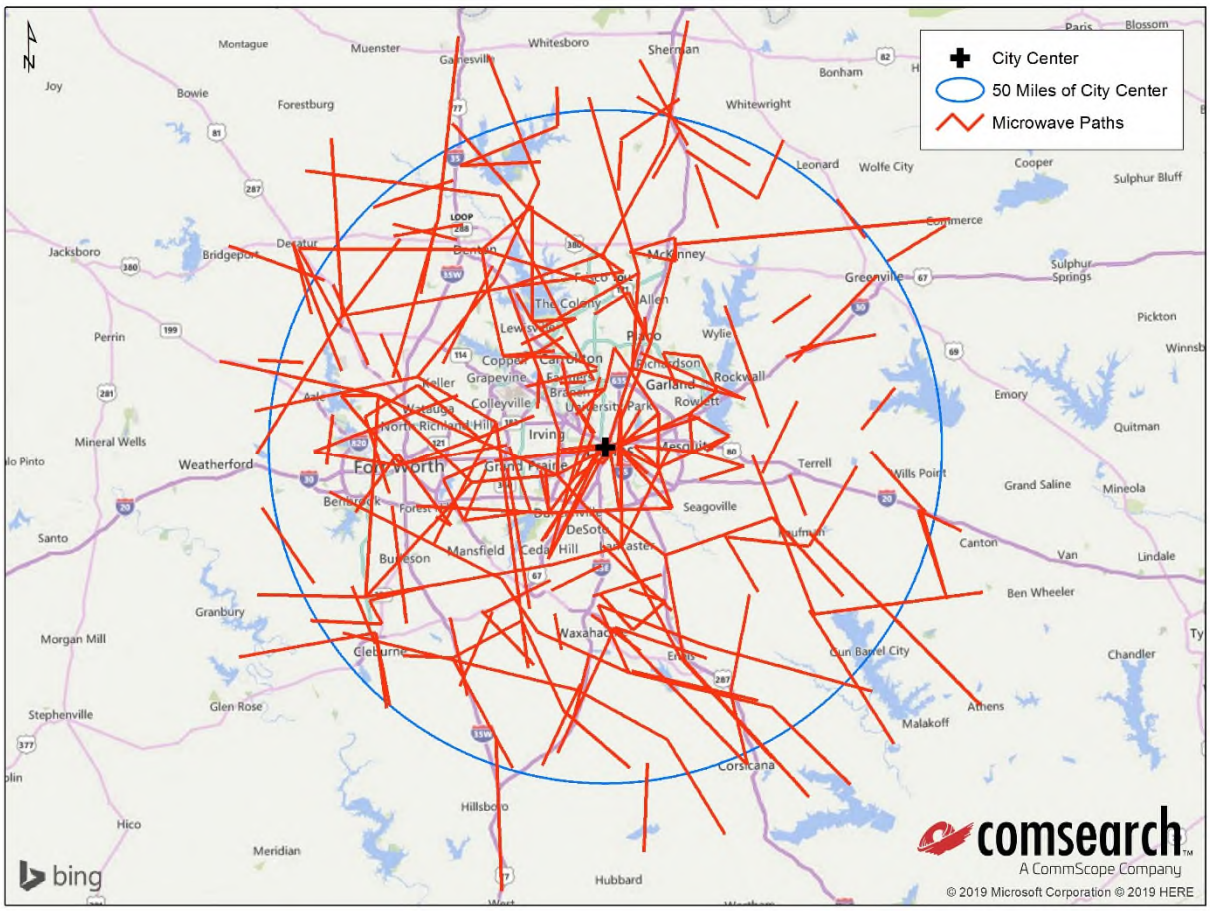

Figure 1: Microwave Paths Within 50 miles of Dallas, TX

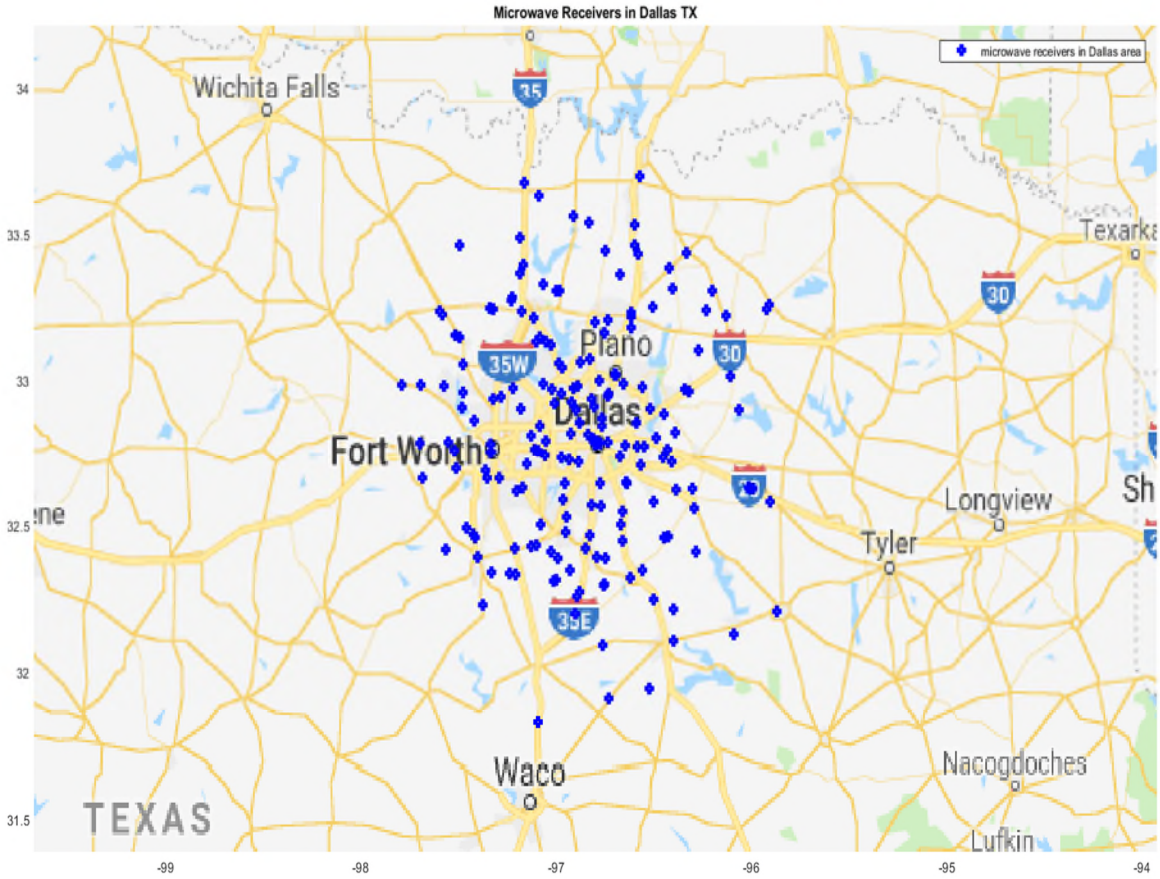

Figure 2: Microwave Receivers Within 50 miles of Dallas, TX

LPI devices were randomly placed up to a distance of 40 km around each FS microwave receiver. A plot of all receivers in the Dallas area and LPI devices simulated around each receiver is shown in Figure 3.

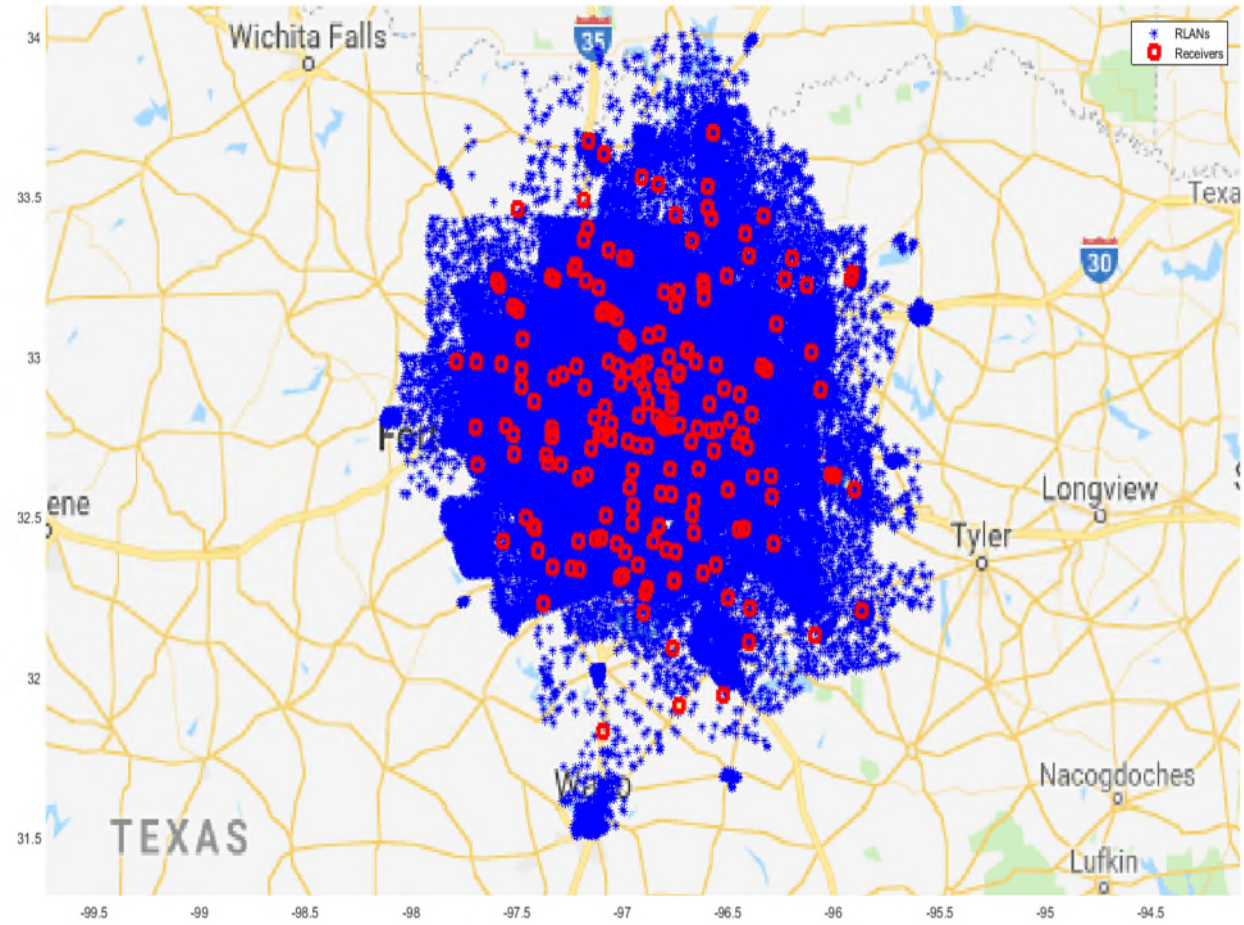

Figure 3: Random Placement of LPI Devices at 40 km Around FS Receivers

The remaining simulation parameters are listed below:

- Mean density of LPI devices is assumed to be 0.7-1.0 per km^2 in urban and suburban areas.[51]
- LPI transmit power is limited to a mean EIRP of 17 dBm/MHz using an omnidirectional antenna.
- All LPI devices are assumed to be placed indoors with antenna height of 1m to 6m.
- No LPI devices are placed within 30m of the microwave receiver. This is consistent with other studies.[52]
- Winner-II path loss model is used to calculate propagation loss from LPI devices placed between 30m to 1km of the microwave receiver.

[51] We note the density assumed by the RKF Study is two orders of magnitude (100 times) larger.

[52] See RKF Study for example.

- ITM with ITU-R P.2108 statistical clutter loss model (shown in **Error! Reference source not found.**) is used to calculate propagation loss from LPI devices placed within 1km to 40km of the microwave receiver.[53]
- Individual and aggregate interference from LPI devices are calculated for all microwave receivers.

Interference Protection Criteria

The approach in any sharing mechanism is to limit the interference into the incumbent to some tolerable limit. Most approaches use the limit of 1 dB front-end degradation, which means the interference will be 6 dB below the noise level.

Using that assumption and using a noise figure, N_f=5 dB[54], maximum interference from LPI devices to microwave receivers is limited to -115 dBm per MHz. This study also calculates the aggregate interference of 1% of simulated LPI devices around a microwave receiver. If there are N LPI devices around a microwave receiver, then the maximum interference that an LPI device can cause will be limited to

$$I_L = -115 - \log10(N * A_g') \text{ dBm} \quad (1)$$

Where, A_g', is the Aggregation factor = 1%

It should be underscored here that in our simulation, the density of LPI devices deployed around a microwave receiver is assumed to be 0.7-1.0 per km^2. Actual deployments in dense urban areas could be two orders of magnitude, or 100 times, higher. In effect that means that the aggregation here is assumed to be only .001 % of the projected LPI device deployments.[55]

Exclusion Zones

Any LPI device crossing the I_L limit from (1) above is marked as causing interference to microwave receivers. We performed a Monte Carlo simulation for each microwave receiver with LPI devices randomly distributed around the receiver and the LPI device location crossing the limit for each angle around the receiver is averaged over the runs. This provides insight into the exclusion area around each receiver.

[53] The impact of RLAN interference beyond 40km of the microwave receiver is not considered in this study but should be investigated further.
[54] See RKF Study
[55] *Supra* at 5.

Simulation Results

The results of the Monte Carlo simulations are shown below.

RLAN Distributions

Figures 4 below shows a representative example of the distribution of RLAN devices around one of the microwave receivers in the urban part of the Dallas area. The LPI device density is assumed to be 0.7-1.0 per km^2 in the urban areas. As noted above, it is approximately 1% of LPI devices projected by other studies.

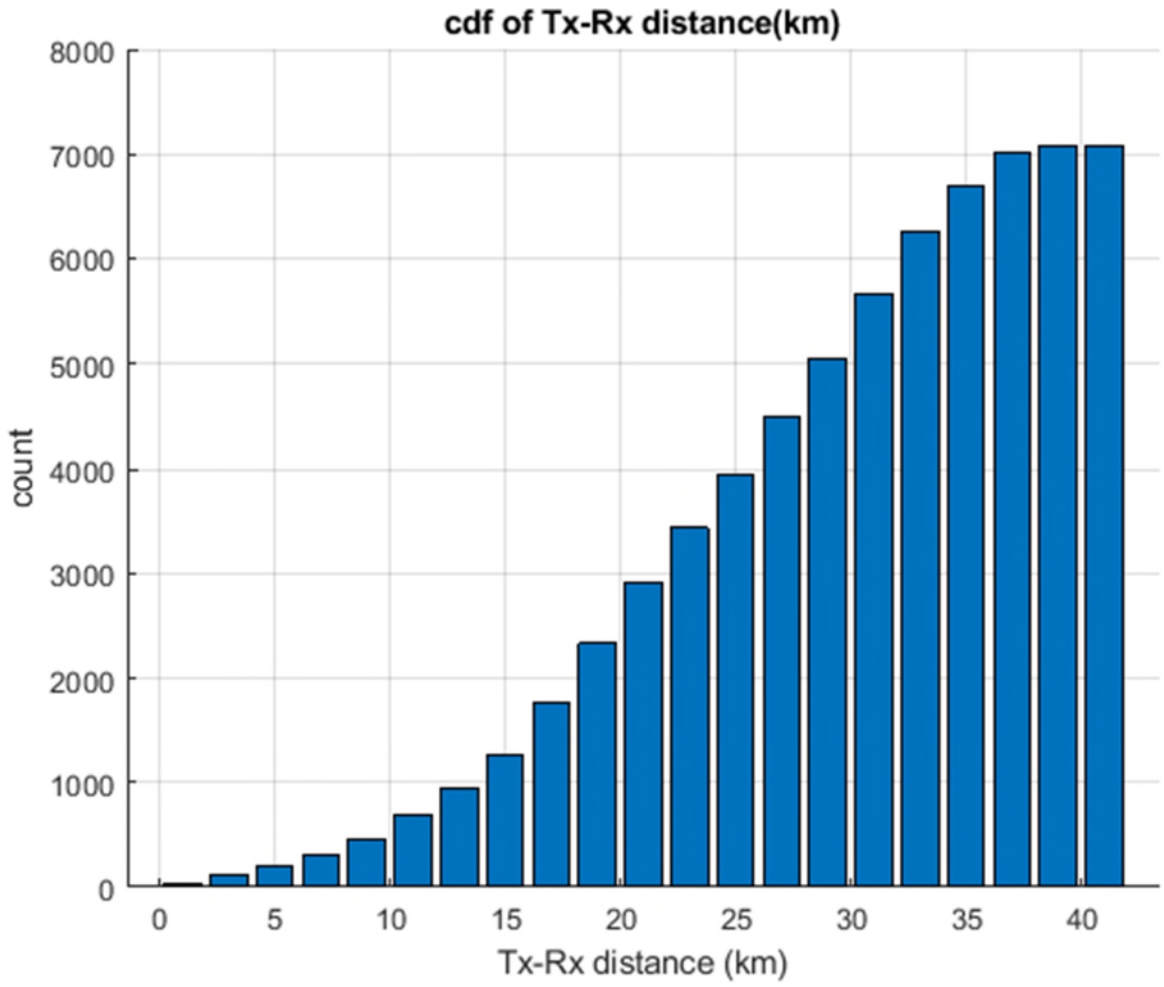

Figure 4 CDF of Number of LPI devices from FS Microwave receiver

Figure 5 below shows placement of LPI devices after a typical Monte Carlo run.

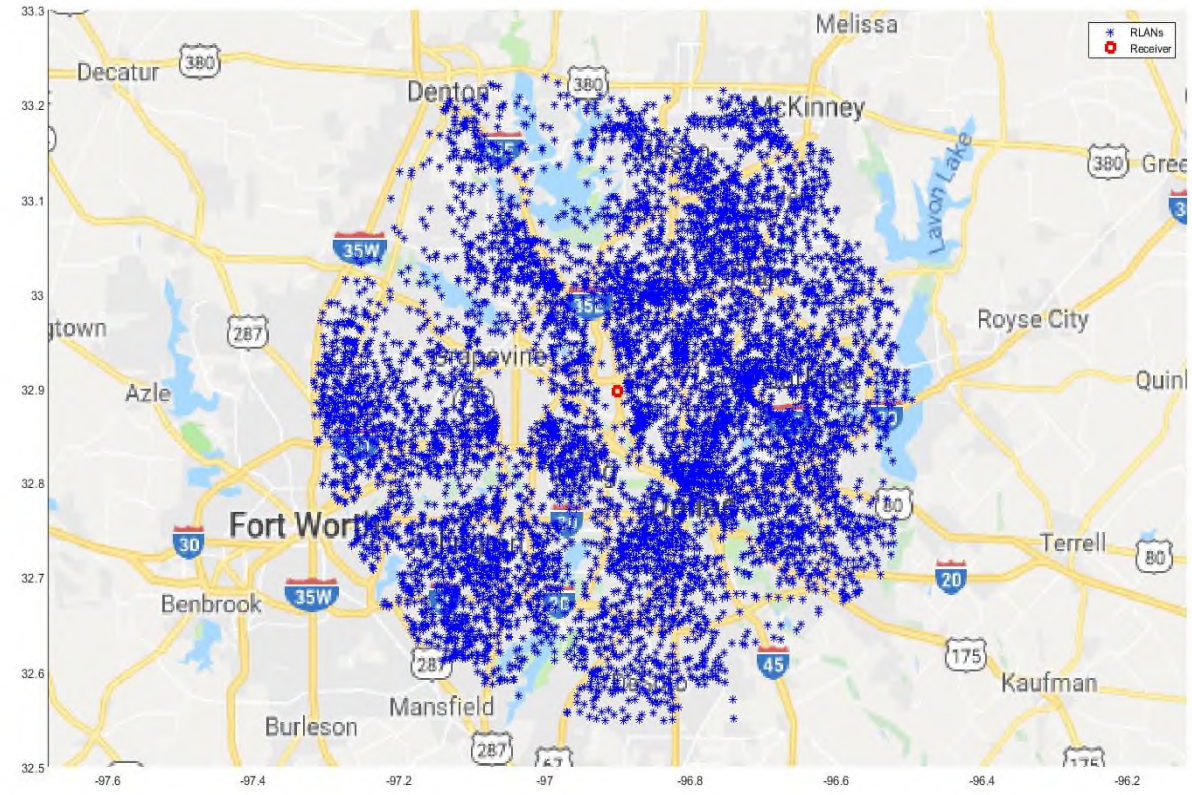

Figure 5: A typical Monte Carlo Run of LPI devices distributed around FS receiver

Interference Analysis Results

Results of the simulation are depicted in Figures 6-9 below.

- Figure 6 shows the cdf of the interference power in dBm/MHz for a typical representative microwave receiver normalized to the protection threshold -115dBm/MHz.
- Figure 7 shows the exclusion area around a typical microwave receiver where the LPI device interference can cross the specified limit I_L [1].
- **Error! Reference source not found.**8 is a plot of the cdf of the interference from all LPI devices within 40 km of the respective microwave receivers.
- Figure 9 shows the average exclusion area around microwave receivers where the LPI device interference can cross the specified limit I_L [1]. Note the exclusion area is averaged over all microwave receivers.
- Figure 10 shows the simulation results depicted as spectrum availability in number of 80 MHz channels

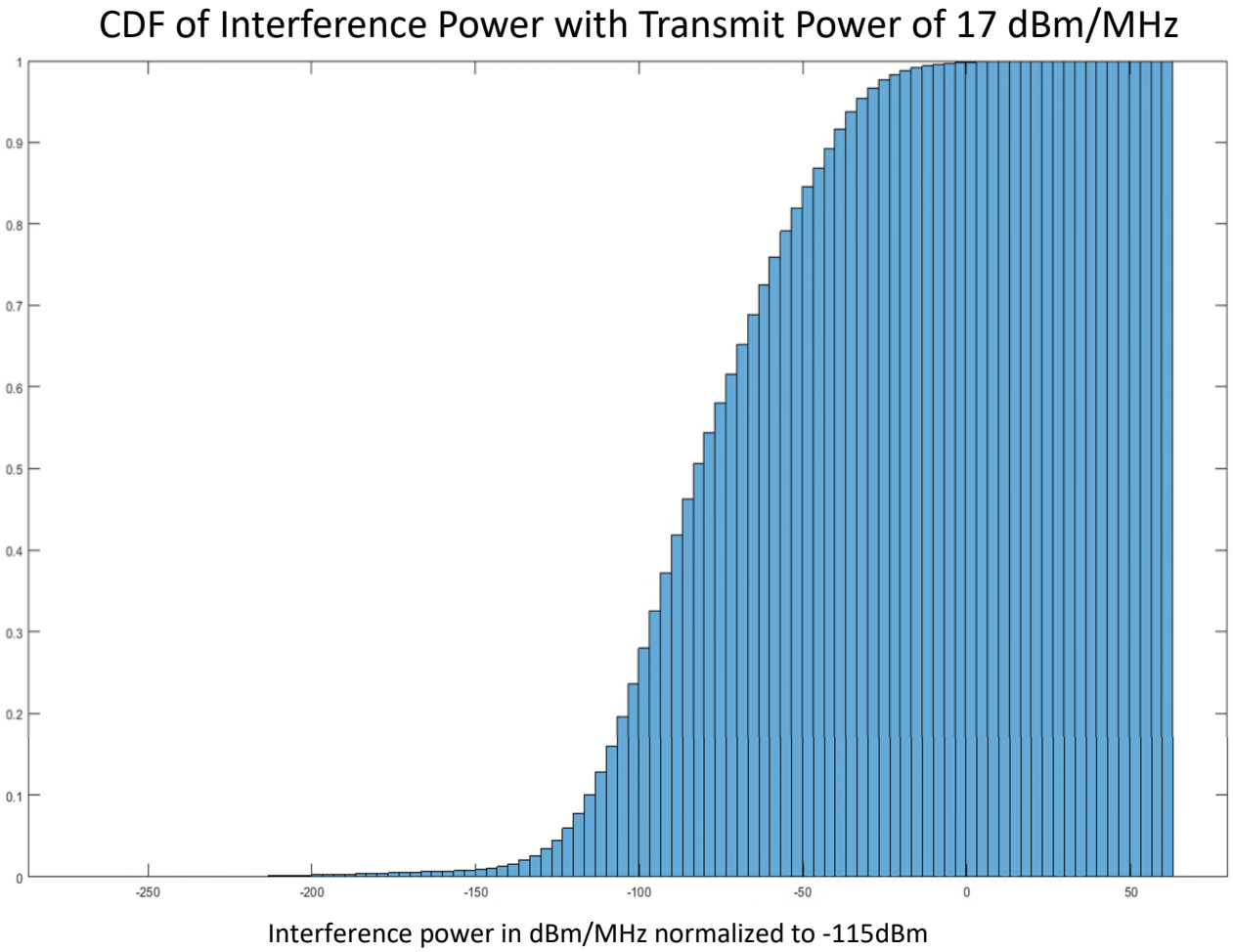

Figure 6: CDF of interference from LPI devices to FS microwave receiver

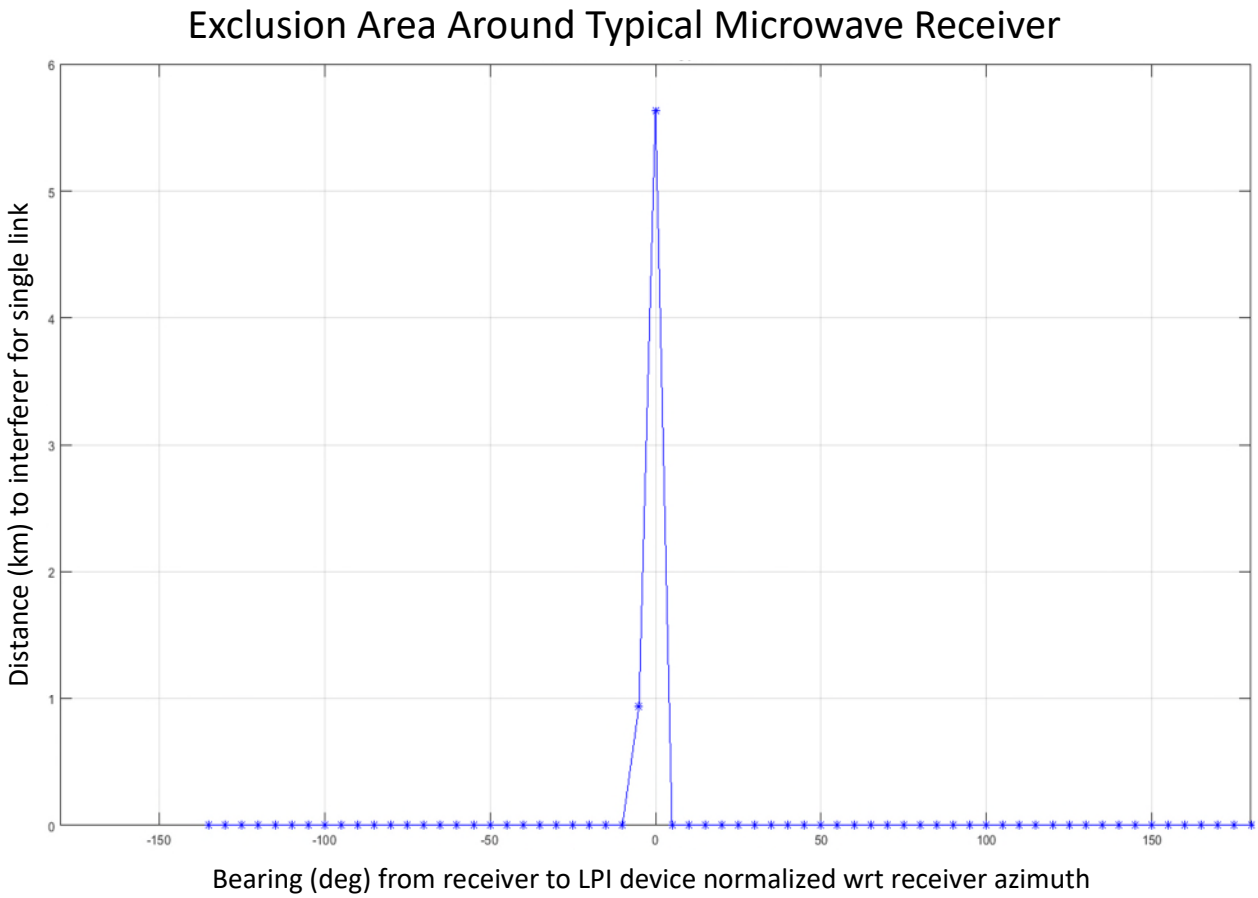

Figure 7: Exclusion Zone Around Typical Microwave Receiver

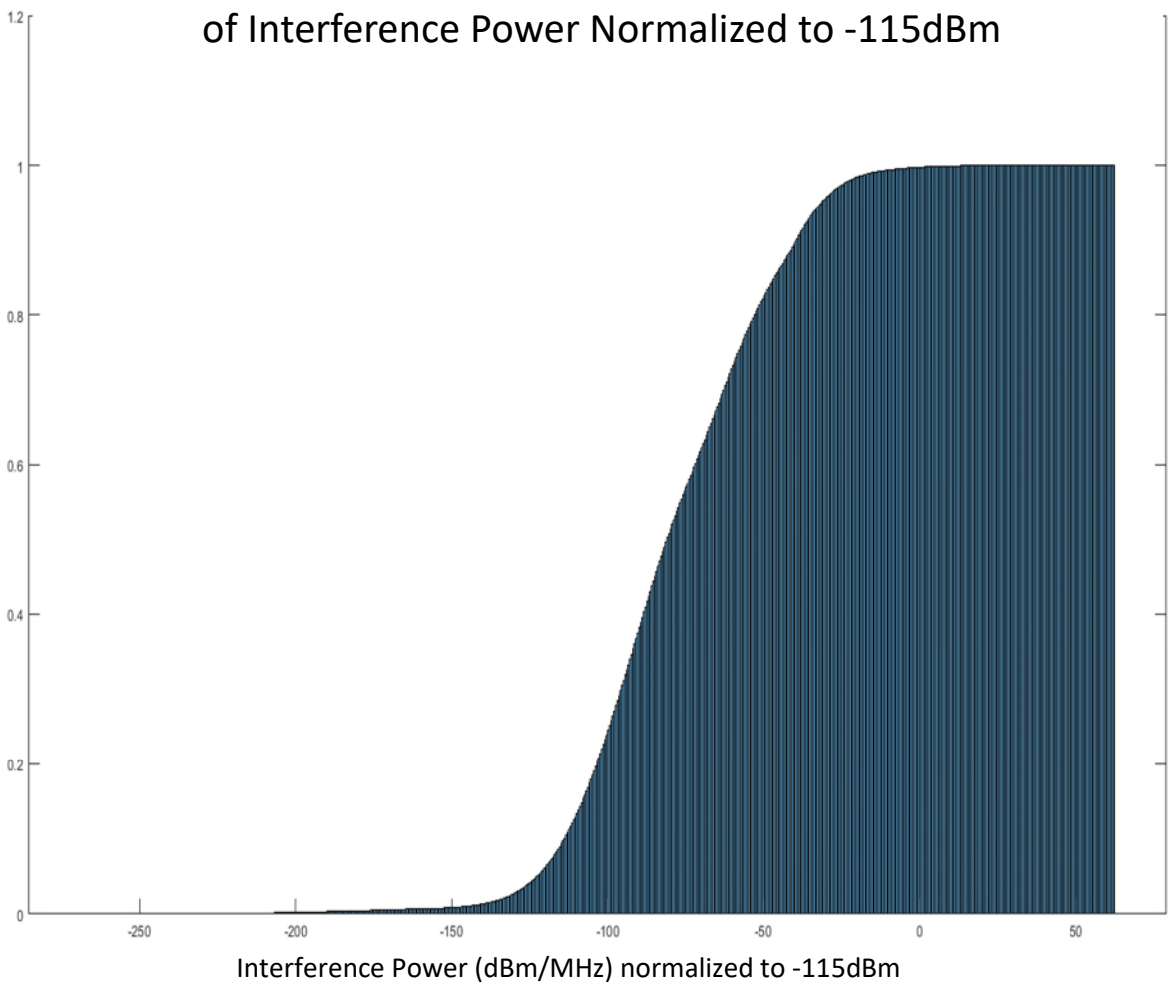

Figure 8: CDF of Interference Power Over All Links

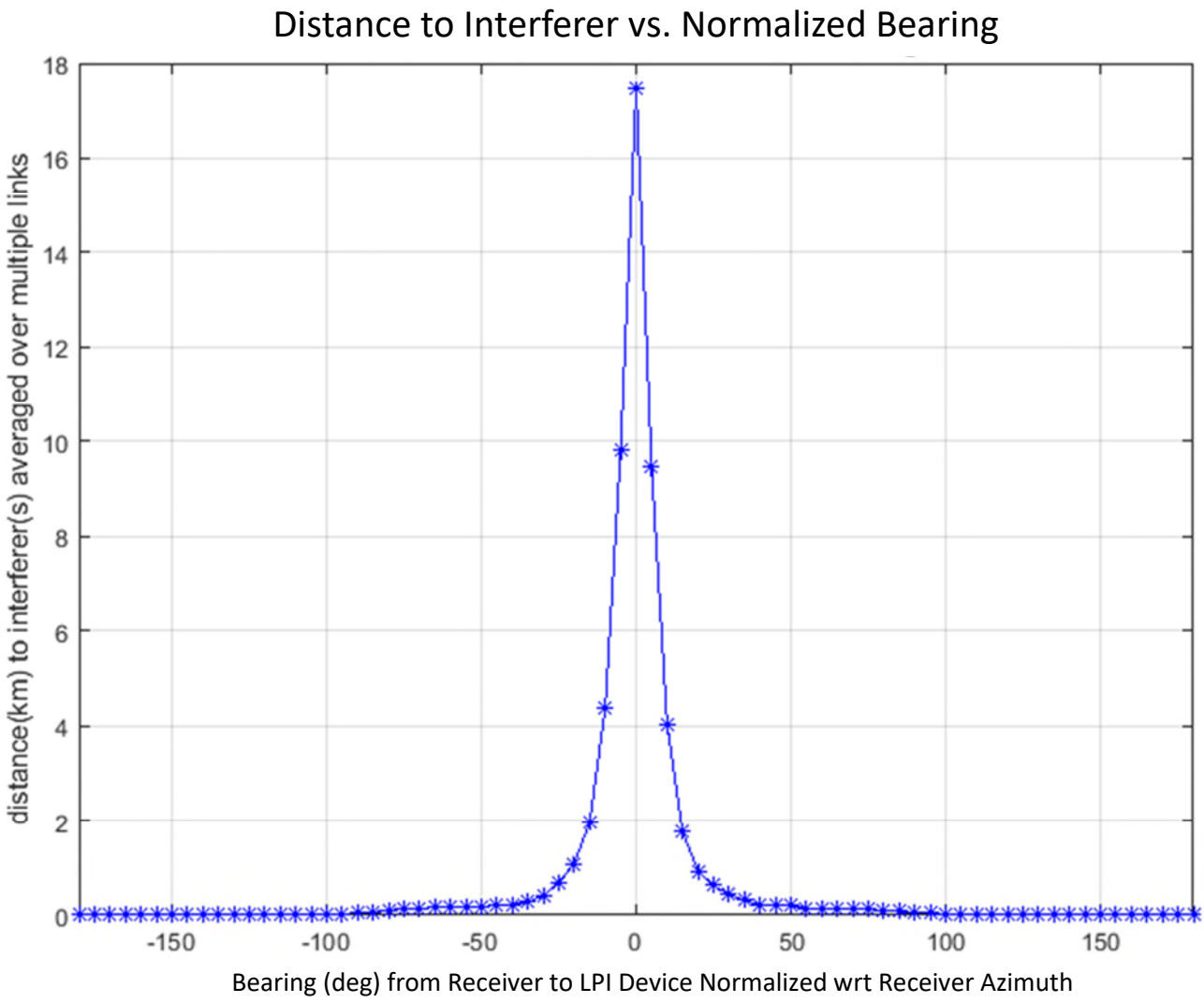

Figure 9: Average Exclusion Zone Area Around FS Receivers

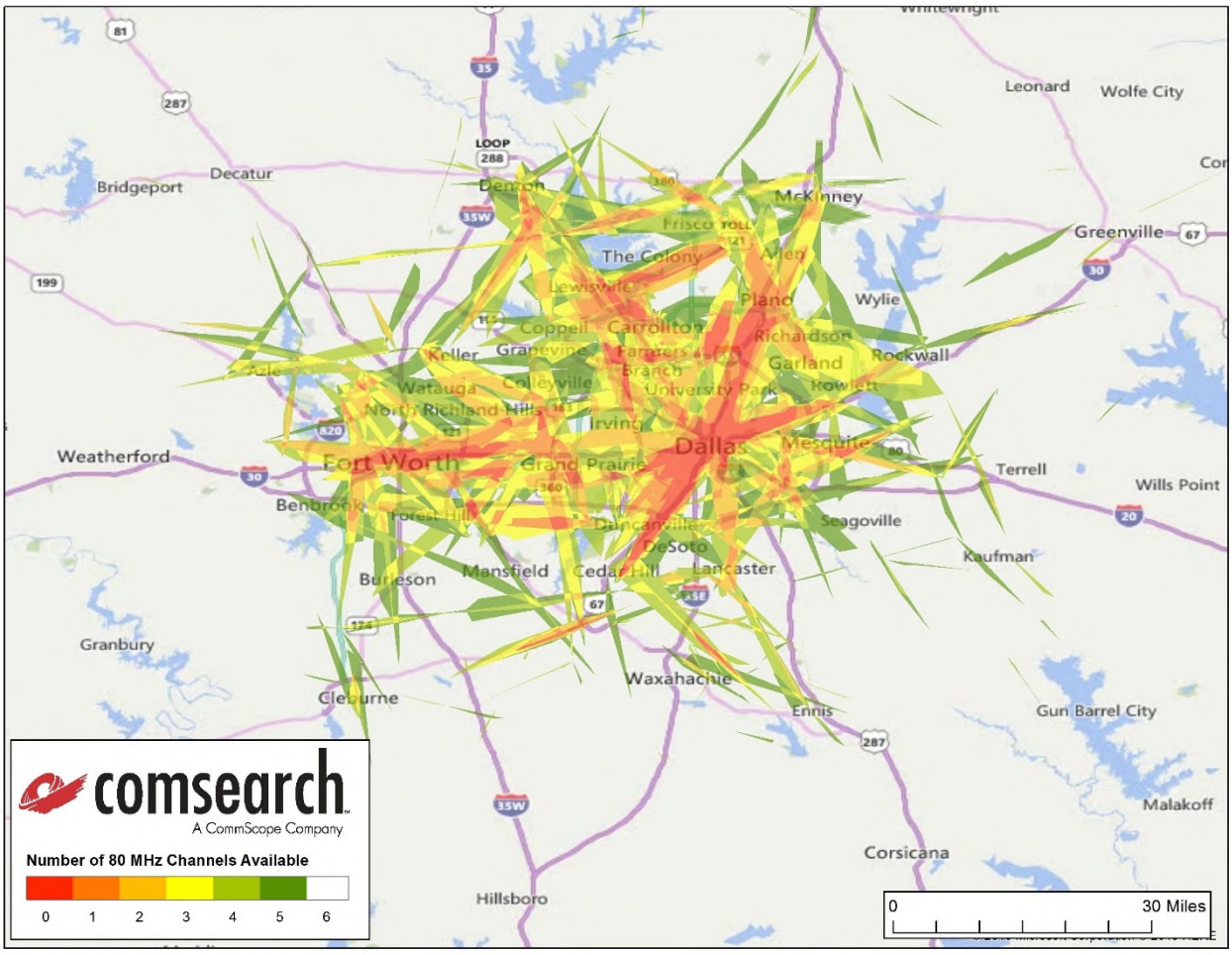

Figure 10: Simulation Results Depicted as Spectrum Availability in Number of 80 MHz Channels

Observations

- Figure 8 shows that some LPI devices can cause interference upward to 40 dB from the protection level.
- The height of the LPI devices is limited to 6m. If LPI devices are placed at higher floors the interference could degrade further. We plan to perform future studies on the dependence of unlicensed device height on interference potential.
- The simulation assumed a mean clutter loss of 31 dB as identified in the ITU-R P.2108. The standard deviation of the clutter in the model is 10-12 dB which if applied, can result higher

interference from an LPI device. We plan to perform future studies on the dependence of clutter loss on interference potential.

- The effective interference aggregation is assumed to be .001% of the projected deployment. This number can vary and we plan to perform future studies on the dependence of aggregation effects on interference potential.
- This study assumed all LPI devices to be indoor. We plan to perform future studies on the effect of outdoor unlicensed devices.

Future Work

As stated in the introduction, interference results can vary depending upon the analysis parameters. We have developed our simulation to allow us to vary several parameters. Some of the future work we are planning is listed below:

- Effect of unlicensed device height.
- Effect of clutter loss.
- Effect of aggregation effects.
- Effect of outdoor unlicensed devices.
- Adjacent-channel considerations